

Military Blast Injury In Iraq and Afghanistan: The Veterans Health Administration's Polytrauma System of Care

Stephen T. Mernoff, MD, FAAN, and Stephen Correia, PhD

The proportion of veterans cared for by the Veterans Health Administration (VHA) is rapidly shifting to those deriving from the Gulf War, which began in 1990 and the Global War on Terror, which began in 2001.¹ The conflicts in Afghanistan (Operation Enduring Freedom, OEF) and Iraq (Operation Iraqi Freedom, OIF), have produced 1,016,213 veterans; and 454,121 of them have received care through the VHA as of the second quarter of 2009.²

As of July 31, 2009, 3980 US service members have been killed and almost 35,000 have been wounded in action in OEF/OIF.³ Explosive blasts have accounted for about 60% of these injuries.^{4,5} Other mechanisms of injury include projectiles (bullets, shrapnel), motor vehicle collisions, falls, and non-combat-related assaults. Service members are surviving combat injuries at much higher rates than in past conflicts⁵ and a high percentage of these individuals have **traumatic brain injury (TBI)**, which has led to TBI's label as the "signature injury" of OEF/OIF.⁶ Estimated rates of TBI in OEF/OIF reported in the media vary widely with some being alarmingly high. However, empirical support for these estimates is limited due to the small sample size, reliance on self-report data, use of data derived from a single center, and restrictive inclusion criteria.⁵ Epidemiological data for injuries in these conflicts continues to develop but a rigorous scientific study of the prevalence of TBI has not been done.⁵

BLASTS, TBI, AND PTSD IN THE MILITARY POPULATION

Blasts are by far the most common cause of wounded-in-action injuries and death in OEF/OIF.^{5,6} The majority of blasts are from improvised explosive devices. The most commonly involved organ systems include skin and muscle, skeletal, pulmonary, gastrointestinal, cardio-

vascular, vestibular, and neurological including brain, spinal cord, and peripheral nerves.

The mechanisms by which blasts cause TBI are unclear but likely arise from a combination of primary and secondary effects. The primary effect derives from the blast pressure wave. Evidence that these pressure waves can cause brain injury derives from animal studies.^{7,8} Secondary effects contributing to blast-related TBI include impact from projectiles launched by the blast or from the victim striking his or her head against the ground or other stationary objects as a result of the blast.

The definition of **mild TBI (mTBI)** adopted by the VHA and **Department of Defense (DOD)** is based on the 1993 American Congress of Rehabilitation Medicine criteria:

Mild traumatic brain injury is a traumatically-induced structural injury or physiological disruption of brain function resulting in one of the following: brief alteration in consciousness (dazed, disoriented, or confused), or **loss of consciousness (LOC)** of 30 minutes or less, or 24 hours or less of **posttraumatic amnesia (PTA)**, i.e., a loss of memory for the period surrounding the event that may occur with or without LOC).

It is unknown whether the nature or prognosis of blast-related mTBI differs from other causes of mTBI. Recent data suggest that the cognitive profiles of patients with blast-related vs. impact-related mTBI are similar.⁹ Blast-related mTBI may have a stronger association with PTSD than other causes of mTBI.⁵ Recent studies have demonstrated a high rate of comorbidity with **post traumatic stress disorder (PTSD)**.¹⁰⁻¹² As of the

first quarter of 2009 approximately 102,000 of OEF/OIF veterans have been diagnosed with PTSD.²

Postconcussive and PTSD symptoms overlap considerably but not completely.¹³ Shared symptoms include depression/anxiety, insomnia, appetite changes, irritability/anger, concentration difficulty, fatigue, hyperarousal, and avoidance. Symptoms more uniquely associated with persistent postconcussive syndrome include headache, heightened sensitivity to light and sound, dizziness and disequilibrium, and memory impairment. Symptoms that are more unique to PTSD include re-experiencing, shame, and guilt. Nonetheless, accurately parsing the extent to which an individual's symptoms are attributed to PTSD vs. TBI is difficult, especially when relying on retrospective self-report of a temporally remote event. Many believe that it is more parsimonious and clinically useful to conceptualize these symptoms as a single syndrome rather than two distinct entities. One term that has been proposed is **Combat-Related Brain Injury and Stress Syndrome** (David X. Cifu, personal communication, October 2007). One of the authors (S.M.) has used the term "**Deployment-Related Cognitive Impairment**" to refer to the frequent cognitive complaints of inattention and forgetfulness. This term aligns well with previous findings of deployment-related neuropsychological deficits in army personnel deployed in the Iraq war.¹⁴

POLYTRAUMA SYSTEM OF CARE

The rate of survival of combat injuries in OEF/OIF, including TBI, is approximately 90%¹⁵—considerably higher than in previous conflicts. The high survival rate is due mainly to improvements in helmet and body armor and to improved delivery of medical care including battlefield and in-theater hospital innovations.⁵ This has led to a high number of veterans with re-

Report Documentation Page			Form Approved OMB No. 0704-0188		
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE JAN 2010		2. REPORT TYPE		3. DATES COVERED 00-00-2010 to 00-00-2010	
4. TITLE AND SUBTITLE Military Blast Injury in Iraq and Afghanistan: The Veterans Health Administration's Polytrauma System of Care				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Providence VA Medical Center,8.30 Chalkstone Ave,Providence,RI,02908				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 5	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

habilitative needs. In response, the VHA established the Polytrauma System of Care in 2004 with a mission "To ensure that the needs of injured service members and Veterans are met."¹⁶ The VHA defines polytrauma as follows:

"...two or more injuries sustained in the same incident that affect multiple body parts or organ systems and result in physical, cognitive, psychological, or psychosocial impairments and functional disabilities. TBI frequently occurs as part of the polytrauma spectrum in combination with other disabling conditions, such as amputations, burns, pain, fractures, auditory and visual impairments, PTSD, and other mental health conditions. When present, injury to the brain is often the impairment that dictates the course of rehabilitation due to the nature of the cognitive, emotional, and behavioral deficits related to TBI."¹⁶

The system is a hierarchy of facilities with particular roles:

Polytrauma Rehabilitation Centers (PRC) provide acute high-intensity rehabilitative and medical care for the seriously injured. There are four PRCs, located at VA Medical Centers in Tampa, FL; Richmond, VA; Minneapolis, MN; and Palo Alto, CA. A fifth center is under construction at San Antonio, TX.

Polytrauma Network Sites (PNS) provide post-acute inpatient and outpatient interdisciplinary rehabilitative care of moderate intensity for medically stable patients. Each of VHA's 22 **Veterans Integrated Service Networks (VISNs)** has one PNS. The PNS for the New England region (VISN-1) is the Boston VA Health Care System.

Polytrauma Support Clinic Teams (PSCT) are interdisciplinary teams that manage medically stable outpatients with an interdisciplinary treatment plan. Patients are moni-

tored for progress and the team identifies unresolved problems and implements solutions. Eighty one PSCTs have been established nationally.

Polytrauma Points of Contact (PPOC) are staff members at all remaining VA facilities who assist veterans in accessing the Polytrauma system.

Patients can be referred up or down the hierarchy in accordance with their medical needs and the services provided at the various facilities.

POLYTRAUMA SYSTEM: SCREENING FOR TBI

VHA Directive 2007-13 established screening of all service members returning from deployment in OEF/OIF to determine if they had possibly sustained a deployment-related traumatic brain injury that had not already been diagnosed. In response, the VA Polytrauma Program developed a standard, two-tier screening process implemented nationally. The data collected is entered into the VA's electronic medical record system and is tracked nationally.

The initial screen, called the "TBI Clinical Reminder," is required for all OEF/OIF veterans who enter the VA health care system. The Reminder consists of a set of yes-no questions organized into four sections that determine whether or not the veteran experienced the following: exposure to a deployment-related event with risk for TBI; acute alteration of consciousness; postconcussive symptoms during the immediate post-acute phase; persistence of such symptoms currently. A positive screen is defined as an affirmative response to all four sections; a negative response to any section results in a negative screen. The reliability and validity of the screen have not been established, and is under research investigation.

Veterans who screen positive are referred for a "Comprehensive Second-Level Evaluation" which consists of a standard, more detailed assessment of TBI. It is intended to determine more accurately the likelihood that a veteran sustained a TBI and to estimate the severity of the injury. It also assesses symptoms, elicits clinicians' opinions about the like-

lihood that the symptoms reflect the effects of TBI and/or other factors (e.g., psychiatric disorder), and establishes a treatment plan. At most VA facilities, the "Second-Level Evaluation" is performed by a "TBI specialist," typically a psychiatrist or neurologist, who leads the polytrauma team at that facility.

Except in relatively rare cases in which documentation is available, the initial screen and the Second-Level Evaluation typically rely on patients' recall of their injuries. This is an important limitation to the system because retrospective self-report of an event or events that occurred many months or years earlier may be unreliable. Moreover, the intense emotional reaction to the chaotic event of a blast may well acutely and transiently alter cognitive function which could masquerade as TBI or enhance its effects and it can be very difficult teasing these factors apart. At the PVAMC, we have adopted a fairly parsimonious clinical guideline for determining the presence of absence of TBI: a patient who can relate a continuous narrative before/during/after an event seems unlikely to have suffered a physiologic disruption of brain function. We have found this guideline to be quite helpful in ambiguous cases but its reliability and validity have not been determined.

DIAGNOSIS OF TBI IN THE POLYTRAUMA SYSTEM

National Experience (data rounded off to nearest 1000):

The TBI Clinical Reminder was implemented in April 2007. Through May 31, 2009, 316,000 veterans have completed the Clinical Reminder; 63,000 (20%) screened "positive" for possible TBI. Of these, 41,000 completed the Comprehensive Second-Level Evaluation which confirmed the mTBI diagnosis in 20,000 (49%). This estimate does not include an additional 9440 veterans who self-reported having been previously diagnosed with TBI during their deployment.

There is considerable variability across VA Medical Centers in the rate at which mTBI is diagnosed by this process. Potential reasons include variability in the combat roles of military units based in different geographical regions of the U.S. (some combat roles carry

greater risk for TBI than others), variability in TBI experience of clinicians performing the evaluations, and the institutional learning curve given the fact that the process was introduced relatively recently.

Providence VAMC Experience:

Through May 31, 2009, the PVAMC has screened 1672 veterans with the Clinical Reminder; of these, 262 (15.7%) have screened "positive." Of these positive screens, 184 have completed the Comprehensive Second-Level Evaluation, which confirmed the mTBI diagnosis in 120 (65%).

Our Polytrauma Team functions as a PSCT (official designation by VHA is pending). The team is led by a neurologist specializing in neurorehabilitation/TBI and includes a social worker/case manager, neuropsychologist, primary care physician, and a psychologist specializing in PTSD, as well as a physical therapist, occupational therapist, speech therapist, ENT nurse practitioner, and hearing and vision specialists. Other disciplines are consulted as needed. The team meets weekly to review veterans new to the Polytrauma Team and to provide periodic review of established patients.

A weekly Polytrauma intake clinic (neurologist, neuropsychologist, social worker/case manager) screens newly referred veterans to identify ongoing problems and develop a treatment plan. In addition, the neurologist and case manager have a weekly Polytrauma/TBI follow-up clinic in which veterans with ongoing medical and psychosocial problems are seen as needed. The majority of patients seen by our team likely sustained mTBI during their OEF/OIF deployment without concomitant severe somatic injuries.

SYMPTOM MANAGEMENT

The most common complaints of patients in the Polytrauma Clinic include pain (mostly headaches and back pain), dizziness, hearing loss/tinnitus, sleep difficulty, anxiety and symptoms of PTSD, and cognitive complaints such as forgetfulness and diminished concentration.

As there is no "specific" treatment for cognitive complaints in mTBI, emphasis is placed on identifying and treat-

ing modifiable factors such as PTSD, depression, substance abuse, sleep deprivation, pain, and other factors such as loss of employment and marital distress, that might be contributing to veterans' symptoms and which, if adequately treated or addressed, could have a positive impact on their quality of life. The Polytrauma Team makes referrals to specialists and VA programs as needed and promotes veterans' compliance with treatment plans. The most common referrals are to the PVAMC Mental Health and Behavioral Science Service, particularly to the PTSD Clinic, the Returning Veterans Program, the Substance Abuse Treatment Program, and to the Neuropsychology Clinic. Referrals to Physical Therapy and Speech and Language Pathology services (the latter for cognitive retraining) are also common. The Polytrauma Team emphasizes educating patients and their families about the expected trajectory of recovery from mTBI and the possible treatable factors. Such interventions have been shown to reduce the likelihood of patients with mTBI developing persistent postconcussion syndrome.^{17,18}

**As of the first
quarter of 2009
approximately
102,000 of OEF/
OIF veterans have
been diagnosed
with PTSD.**

MILD TBI: CONTROVERSIES

Hoge et al¹⁹ raise several concerns about the DOD/VA process for diagnosis and management of mTBI. First, they postulate that the screening process risks incorrect attribution of non-specific symptoms to mTBI. Second, they suggest that disability may be overly attributed to mTBI, and they raise the possibility that "post-deployment screening is...likely to promote negative expectations for recovery." They also assert that misattribution of symptoms to mTBI potentially places veterans at risk of negative consequences, including medication adverse effects, failure to

adequately address concurrent conditions (e.g., depression, PTSD, substance abuse, etc.), and inappropriate use of rehabilitation procedures. They suggest development of improved definitions and diagnostic criteria and processes.

The VHA's standardized team approach aims to minimize over-diagnosis and misattribution errors via thorough Second-Level Evaluations that assess for co-existing conditions that may be contributing to symptoms and addressing them appropriately. Many believe that the benefit derived from the thoroughness of this process in identifying and addressing previously untreated symptoms outweighs the risk of over-diagnosis, and that when managed by trained physicians and ancillary providers, the risk of negative consequences is minimal, if present at all. Finally, the data to design improved diagnostic criteria are not yet available.

CONCLUSIONS

Veterans of conflicts occurring over the last nineteen years often have complex, multisystem injuries, and a large number are being diagnosed with mild TBI with significant comorbidities including PTSD and somatic injuries, particularly auditory/vestibular injuries. The Polytrauma System of Care is designed to standardize the diagnosis and management of these conditions nationwide. Although making the diagnosis of mTBI requires ongoing assessment, our experience at PVAMC has been that the Polytrauma Team has been effective in bringing veterans with multiple injuries and/or medical conditions into the health care system, helping them access the care they need, and monitoring their progress.

ACKNOWLEDGMENTS

The authors thank David Chandler, PhD, Deputy Chief Consultant, Rehabilitation Services, VHA, for his helpful comments on this manuscript. This material is based upon work supported by the Office of Research and Development Rehabilitation R&D Service, Department of Veterans Affairs. The contents of this manuscript do not represent the views of the Department of Veterans Affairs or the United States.

REFERENCES

1. National Center for Veterans Analysis and Statistics. 2007. <http://www1.va.gov/vetdata/docs/21.xls>
2. Bidelsbach D. Personal communication (July 29, 2009). (VHA Office of Public Health and Environmental Hazards, Veterans Affairs Polytrauma Program Office).
3. US Department of Defense. 2009 www.defenselink.mil/news/casualty.pdf.
4. Gawande A. Casualties of war—military care for the wounded from Iraq and Afghanistan. *NEJM* 2004; 351:2471-5.
5. Ling G, Bandak F, et al. Explosive blast neurotrauma. *J Neurotrauma* 2009; 26: 815-25.
6. Warden D. Military TBI during the Iraq and Afghanistan wars. *J Head Trauma Rehab* 2006; 21:398-402.
7. Cernak I, Wang Z, et al. Ultrastructural and functional characteristics of blast injury-induced neurotrauma. *J Trauma* 2001;50:695-706.
8. Cernak I, Wang Z, et al. Cognitive deficits following blast injury-induced neurotrauma. *Brain Inj* 2001;15:593-612.
9. Belanger HG, Kretzmer T, et al. Cognitive sequelae of blast-related versus other mechanisms of brain trauma. *J Int Neuropsychol Soc* 2009;15:1-8.
10. Hoge CW, et al. Mild traumatic brain injury in US Soldiers returning from Iraq. *NEJM* 2008; 358:453-463.
11. Schneiderman AI, Braver ER, Kang HK. Understanding sequelae of injury mechanisms and mild traumatic brain injury incurred during the conflicts in Iraq and Afghanistan. *Amer J Epidemiol* 2008; 167:1446-52.
12. Vanderploeg RD, Belanger HG, Curtiss G. Mild traumatic brain injury and posttraumatic stress disorder and their associations with health symptoms. *Arch Phys Med Rehabil* 2009; 90: 1084-93.
13. Stein MB, McAllister TW. Exploring the convergence of posttraumatic stress disorder and mild traumatic brain injury. *Amer J Psychiatry* 2009;166:768-76.
14. Vasterling JJ, et al. Neuropsychological outcomes of army personnel following deployment to the Iraq war. *JAMA* 2006;296:519-29.
15. Goldberg M. Testimony before the Committee on Veterans' Affairs, U.S. House of Representatives, (Congressional Budget Office, 2007).
16. Department of Veteran Affairs, Veterans Health Administration, Directives 2009-028.
17. Miller LJ, Mittenberg W. Brief cognitive behavioral interventions in mild traumatic brain injury. *Applied Neuropsychol* 1998; 5: 172-83.
18. Mittenberg W, Canyock EM, et al. Treatment of post-concussion syndrome following mild head injury. *J Clin Experimental Neuropsychol* 2001;23:829-36.
19. Hoge CW, Goldberg HM, Castro CA. Care of war veterans with mild traumatic brain injury—flawed perspectives. *NEJM* 2009;360:1588-91.

Stephen T. Mernoff, MD, FAAN, is Chief, Neurology Section, and Leader, Polytrauma Team, Providence VA Medical Center, and Assistant Professor of Neurology (Clinical), The Warren Alpert Medical School of Brown University.

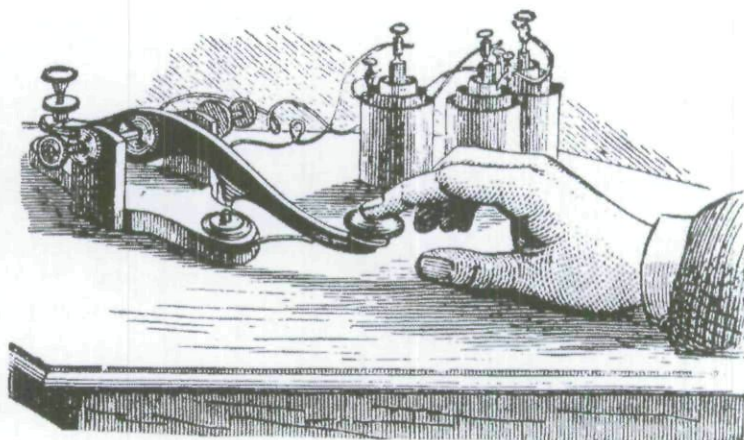
Stephen Correia, PhD, is Neuropsychology Section Chief, Providence VA Medical Center, and Assistant Professor of Psychiatry and Human Behavior, The Warren Alpert Medical School of Brown University.

Disclosure of Financial Interests

The authors have no financial interests to disclose.

CORRESPONDENCE

Stephen T. Mernoff, MD
Providence VA Medical Center
830 Chalkstone Ave
Providence, RI 02908
e-mail: Stephen.Mernoff@va.gov



Copyright of Medicine & Health Rhode Island is the property of Rhode Island Medical Society and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.